EXECUTIVE SUMMARY:

Project 12: Fraser River Sockeye Habitat Use in the Lower Fraser and Strait of Georgia

There is a general view that Fraser River sockeye face a series of challenges and issues which have influenced freshwater and marine sockeye growth and/or survival over at least the past two decades. The lower Fraser River and Strait of Georgia (also known as the Salish Sea) continue to be centres of human activity and development which have changed the natural landscape and potentially altered the extent and characteristics of sockeye habitats. Salmon are often viewed as a living barometer of the conditions in the environment and their habitat state and stock status could reflect potential impacts from human activities.

As part of the Cohen Commission's inquiry, a series of twelve technical reports have been developed to address potential issues identified during the first phase of the Commission's work as being possible causes of an observed long term decline in the production of Fraser River sockeye. The objective of these technical reports has been to explore causal hypotheses related to the observed declines. Within this context, the primary objective of the technical report presented here is to review and summarize potential human development-related impacts over the recent 1990 to 2010 period and to examine potential interactions between human development and activities in the lower Fraser River and Strait of Georgia and Fraser sockeye salmon habitats. Many of the issues and potential interactions between human development and their impacts summarized in this report could potentially apply to other species of wild salmon or other species of fish as well as their habitats; however, the evaluation of effects in this report is focused on Fraser sockeye.

The population of British Columbia has grown to more than 4 million people in 2005 (census data), with 3.2 million people living in urban areas concentrated around the lower Fraser River and the Strait of Georgia. Over the past century, land and resources have been developed and exploited throughout the lower mainland of BC (Fraser Valley and Fraser Delta areas) and the Strait of Georgia for housing, industry, infrastructure, transportation, forestry, agriculture and mining. Many of these activities are near or adjacent to the lower Fraser River and in urban and industrial centres along shorelines around the Strait of Georgia and thus have the potential to interact with the habitats used by sockeye. The Fraser River and the Strait of Georgia both have significant value for human use as commercial, recreation and transportation corridors and as receiving areas for wastewater, along with other human-related functions like water supplies, recreation, irrigation, and fisheries.

The factors used to examine changes in the level of human activities and or possible outcomes of those activities included: population (size, density), land use (agriculture, forestry), large industrial and infrastructure sites and projects, waste (liquid and solid waste), shipping vessel traffic, lower Fraser River dredging and diking, and the Strait of Georgia biological and physical water characteristics including non indigenous (invasive) species and human derived contaminants.

The approach and methods used to identify and define interactions and analyse their potential extent or overlap between human activity and sockeye habitats reflects a similar process to that used in environmental impact assessments.

Key Findings

Our review suggests that Fraser sockeye use specific or key life-history-related habitats with different residence periods (extent of habitat use over time), in both freshwater and marine areas of the lower Fraser and Strait of Georgia. The Strait of Georgia and the lower Fraser River are used by both juvenile and adult sockeye salmon as key habitats and migration corridors on their way to and from the North Pacific. While this may not be the case for some other Pacific salmon species, freshwater and marine habitats used by sockeye often have short residence periods (days); with the exception of incubation in freshwater spawning habitats and rearing in lakes (months to years). In the ocean, sockeye exhibit large annual and seasonal variation in spatial distribution dependent on marine water properties encountered and on preferred prey distribution and abundance. Results from other commission technical reports, our information review and examples from the literature suggest the annual variation in the quality of these conditions (water properties and biological characteristics) may have important links and potential effects on sockeye production. Juvenile sockeye in the Strait of Georgia appear to be particularly sensitive to changes in growth experienced during cool productive and warm unproductive conditions related to prey availability, surface currents and swimming speeds, and potentially to competitors and predators.

Human Activities, Habitat Interactions

Human development across the Georgia basin has seen large changes in population size and density in urban centres. Most of the population is centred in the lower mainland and south-eastern Vancouver Island with population size in most regional districts and municipalities in the lower mainland having increased by 150% over the past 20 years. Changes in population reflects increasing pressures on the environment because of the potential for higher levels of water use and pollution, nutrients and contaminants from wastewater and runoff, conversion of vegetated lands (natural, forests, agricultural) to urban and industrial areas. However, during that same time, programs have been in place to curb and manage runoff and human related discharges. Contaminants in the Strait of Georgia show a general improvement over time, with decreases associated with effluent regulation and improved treatment in recent years. For example, upgrades and efficiencies in the sewage collection and treatment systems in Metro Vancouver have taken place over the period of study. The physical construction of development projects adjacent to sockeye habitats has also been regulated over the period of study and there is evidence that habitat conservation efforts, through regulatory review and through restoration of previously impacted habitats, have resulted in habitat gains in the Fraser River estuary over the period of study for this report (1990 – 2010). However, some of the earlier habitat projects, carried out prior to the present period of study, were not successful at

achieving “no net loss” of fish habitat. There is evidence that information learned from those projects has been incorporated into successful compensatory designs on contemporary projects in the Fraser estuary, underlining the importance of continued scientific learning regarding habitat ecology.

The Strait of Georgia and the lower Fraser River, support a large number of non-indigenous species (NIS), greater than twice the number found elsewhere on the Canada’s West Coast. With the exception of intertidal benthos, the number of NIS in freshwater and marine environments have remained approximately stable from 1990 to 2010.

Increasing population size, urban density, industrial and infrastructure development and associated land use and waste as factors in the decline of Fraser sockeye were ranked as having low to moderate potential for impacts on juvenile and adult sockeye habitats in the lower Fraser River and adult sockeye habitats in the Fraser estuary. As a result of regulatory pressures and technological changes and despite population growth, solid waste, wastewater, contaminants and non indigenous species introductions appear to have remained mostly stable over the time covered by this review, in contrast to Fraser sockeye production which has declined. Changes in urban and rural land use have implications on increased sediment and erosion, nutrient, contaminant and stormwater runoff which could affect sockeye habitat use in the lower Fraser River, particularly in habitats used in locations off of the main channel. For instance, river-type sockeye will make use of the mouths of urban creeks or off-channel areas for rearing prior to migration to the Strait of Georgia. Stormwater and wastes deposited directly or inadvertently would cause direct exposure to sockeye, particularly in freshwater rearing habitats used by river-type sockeye. The proportion of river-type sockeye within the Fraser sockeye population is estimated to be less than 1%.

In many areas where human activities and development are concentrated, sockeye often have limited residence periods in adjacent habitats. For example, the lower Fraser River and estuary are primarily used by both adult and juvenile sockeye over periods of days as migratory corridors,with some exceptions. Historically (i.e., over the past century), many human activities may have had moderate to severe effects on sockeye habitats, but these impacts have not been generally observed during the last 2 decades and importantly, these impacts have not been observed to coincide with the decline of the Fraser River sockeye. The human activities often exhibited limited spatial and temporal (duration, timing) overlap with spatial and temporal sockeye habitat use. In a number of instances, additional regulatory controls (agricultural and forestry practices, shipping, ballast discharge, regulatory review of project development, non indigenous species introductions), improvements to industrial and municipal practices (solid and liquid waste management), and management regimes and protocols (urban development, agricultural and forestry practices, project development, dredging, dikes) have resulted in reduced or declining potential effects and reduced interactions and risk of loss or degradation of existing sockeye habitats relative to periods prior to the last two decades. There is room for continued improvement in a number of these areas.

This review is specific to sockeye and their habitat use and should not be extrapolated to interactions between human activities and other salmon and fish species’ habitats.

Water properties (sea surface temperature, salinity, Fraser River discharge, prevailing winds on the sea surface) and biological conditions (plankton, fish) in the Strait of Georgia show a large range of variation over seasons and years. Potential interactions between biophysical conditions in the Strait of Georgia and sockeye (habitat and habitat use) have been inferred by our findings but limited existing studies and data prevent an adequate analysis of the extent of these interactions and, in particular, causal links cannot be established. Existing studies suggest that there may be an association between changes in biophysical conditions in the Strait of Georgia and the effects on sockeye habitat use, feeding and growth and potentially production. This expectation is not supported by conclusive results and statistical hypothesis tests, but is supported by studies which suggest that Fraser sockeye production is expected to be higher with increased sockeye growth and condition, relative to poorer sockeye production in years, seasons and habitats linked to lower growth and condition. Cooler years in the Strait of Georgia are expected to comprise habitats with higher abundance and availability of preferred (larger sized, higher energy content) sockeye prey and lower levels of competitors and predators. Relative to other human factors examined in our review, the changes and variability in the biophysical conditions associated with cool or warm water years can be widespread, extending over large areas of sockeye habitats and portions of life history for both juvenile and adult stages. In some seasons or years, changes in biophysical conditions and resulting sockeye preferred food availability can be expected to have profound positive or negative effects on sockeye growth and production.

Habitat Protection Strategies

The habitat protection strategies used in the lower Fraser River and Strait of Georgia, appear to be effective at supporting sockeye habitat conservation. More broadly, a hypothesis that the declines in Fraser River sockeye production over the period 1990 – 2009 are the result of habitat impacts from project development is not supported by the net habitat gains that have occurred over the 1990 – 2010 period.

The development of a project is required to provide compensatory fish habitat to offset project-related disturbances/impacts and often provides an opportunity for habitat gains. However, we also found evidence that habitat losses associated with project development had occurred prior to the period covered by our review. These losses were presumably the result of inadequate knowledge and experience in the design and construction of habitat compensation and / or indicate that the regulatory review process may not have been appropriately used. Therefore, maintaining active review of habitat projects may be a critical habitat management approach and potentially an important requirement for current and future activities and human development projects. Although the effectiveness of habitat compensation projects in the Fraser River appears to be improving, the need for an improved habitat science, monitoring and data management framework is clear and aspects of this need are consistent with recommendations made by others over the past decade or two. In our view, some efforts have been made in this direction, but these have not been adequate and are even less likely to be adequate into the future. Habitat compensation techniques relied upon over the past decade or

two may not be effective in the next decade or two as physical space in urban centres for such compensation becomes more limited. Research in habitat ecology to evaluate alternative approaches to those prevailing today will be needed to adequately evaluate habitat compensation projects.

Programs and management initiatives used to examine and understand the quantitative parameters of habitats, potential losses and gains, habitat quality types and the dynamics of habitat productivity do not appear to be sufficient for keeping track of the current and future status of habitats used by sockeye and potential links and associations to variations in sockeye productivity. Habitat science, management, inventory and reporting should be brought together into an integrate framework as habitat compensation projects become more challenging and environments are more strongly influenced by changing climates and diminishing space in which to construct new habitats.